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Railway Lighting*

Some Lessons from Experience, and Views on the Future

By A. CUNNINGTON, B.Sc. *(Fellow)*, and G. W. GOLDS *(Fellow)*

Synopsis

The paper opens with a discussion of the general requirements of railway lighting installations, and attention is drawn to the special importance for railway purposes of reliability, robust construction to withstand adverse conditions, and good design to secure absence of glare. Special problems are referred to in some detail, and a description is given of special devices, such as under-pit fluorescent lighting for the inspection of locomotives, methods of illuminating the interiors of box wagons in goods sheds, and a suggested method for affording background illumination in shunting yards. Reference is made to the need for low illumination in signal boxes so as to ensure reasonable "dark adaptation" for the eyes of signalmen when observing train movements through the windows, and a section deals with some of the features which may make for greater safety of stairways.

The later part of the paper covers some possible future developments in the use of fluorescent tube lighting, and in the illumination of direction signs and clocks, station name signs, both large and small, and of various train indicator devices and time-table boards. Finally, some reference is made to the effect of better lighting on the welfare and safety of the staff and the travelling public.

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(1) Introduction

Former papers on this subject have usually taken the form of a general review of methods of lighting for the various sections of railway operation, and a good deal of attention has been given to the standards of illumination adopted on platforms, in goods yards and in various office premises. It is the present intention firstly to refer more particularly to certain practical problems that arise in railway service and to discuss the influence of railway conditions on their solution, and, secondly, to attempt some forecast of likely developments in the future, based on the result of trials already carried out.

(2) Safety

The safety of the line has traditionally been an axiom of railway practice and, although permanent way maintenance has always been regarded as a first priority, it is becoming increasingly recognised that lighting may play an important part in contributing to the safety both of passengers and staff.

(2.1.) Safety of Passengers

The safety of passengers is mainly a matter of good quality lighting, although the degree of illumination must not be too low. The lighting engineer is often seriously handicapped in old premises by station construction most unsuitable for the provision of good quality artificial lighting, but with modern buildings, where there has been some co-operation between architect and lighting engineer, good results have been secured, especially where the surfaces of platforms and buildings have been designed with good reflection factors. The latter feature is really fundamental, as seen in the admirable effects obtained from light tiled walls in tube stations. Yet other railways seem to be slow in following this example, perhaps partly because of the difficulty in keeping light surfaces clean. Given good and ample lighting, the safety of passengers can easily be taken care of. The only appreciable difficulties arise in respect of staircases and in moving trains coming slowly to rest. Some fuller reference to staircases is made in a later paragraph, but the problem of rendering a platform clearly visible to a passenger getting ready to alight from a moving train is more than one of mere illumination. One of the lessons learnt in the black-out was the value of alternating patches of contrasting reflecting power. These serve to draw the attention of an impetuous passenger to the fact that the train has not quite stopped.

(2.2.) Safety of Staff

This is a more complex matter. Here risks are being taken often throughout the night, and it is imperative that every step shall be taken to enable staff to see movements of vehicles, to avoid any possibility of stumbling at staff crossings, or falling into engine inspection pits, etc. For economic reasons there is a tendency to concentrate on high illumination at certain places, such as where the major work is done, leaving the remainder of a shunting yard in comparative darkness. This is rather the reverse of the careful grading which lighting engineers recommend, and it is probable that more attention to a general background level of illumination throughout the premises would make for safer and more efficient working.

(3) General Requirements of Railway Lighting Installations

Obviously the reliability of the lighting equipment and services is paramount and, in considering the introduction of any new devices, the railway

lighting engineer is bound to ask first of all, "Will this be more or less liable to failure in any respect, than the device we have hitherto used?" It is, therefore, reasonable to give reliability the first priority in the requirements of railway lighting installations. This and other features may be conveniently listed as follows:—

(1) General reliability
(2) Robust and foolproof construction
(3) Absence of glare and dark shadows
(4) Avoidance of deterioration due to adverse atmospheric conditions.

(3.1.) General Reliability

Reliability is not only a question of good design of fittings and robust construction. It is also dependent largely on simplification and the general avoidance of over-elaboration in controls and various devices. It is, for example, very easy to over-elaborate switch controls. It is obviously no use providing a large number of separate switches controlling individual lamps or circuits if, in practice, the whole of an installation has to be in regular use during the hours of darkness. All that is necessary in such cases is the provision of suitable isolating switches for dealing with repairs on sections. On the other hand, simplification of circuits must not be allowed to lead to a state of affairs in which failure of one fuse might extinguish the lighting over a considerable area. It is paramount for safety purposes that lamps be arranged in alternate circuits in every important area of working.

Two examples of designs that combine simplicity with effective illumination are shown in Figs. 1 and 2.

Fig. 1. Hexagonal opal reflector fittings mounted on concrete standard with station name displayed on enamel plate.

(3.2.) Robust and Foolproof Construction

A respect in which railway premises are unusual and which has its influence on the selection of apparatus is the fact that railway platforms and buildings are virtually open to the public at all times of the day and much of the night, and all this time the premises are practically *unattended*. Of course, a limited staff is on duty, but in proportion to the large area covered by an ordinary station and yard, the amount of supervision given by the staff is negligible and, in consequence, the equipment generally (and perhaps especially the lighting fittings) are very much at the mercy of persons with mischievous intent. In this respect stations are very different from shops, stores and other lock-up business premises and it is unfortunately necessary that all the equipment on a station shall be as nearly as possible foolproof, in fact one may say "hooligan-proof." This means

that quite a number of useful lighting devices cannot be employed on a railway because they would not last more than a few weeks.

(3.3) Absence of Glare and Dark Shadows

Whilst freedom from glare is becoming increasingly recognised as one of the important characteristics of most modern lighting installations, it is perhaps even more essential in railway operating, owing to the many traps and sources of danger that may arise if the eye is subjected to strain, or if dark shadows are allowed to interfere with a perfect clarity of vision. Not only on station platforms, where luggage is so often left carelessly to form an obstacle, but even more in shunting yards, where life itself may be involved, is it of paramount importance to have the best *quality* of light. Such factors as good diffusion and absence of glare are of much greater importance than the intensity of the illumination, and experience has shown many times that high intensity alone is not enough.

Fig. 2. Three-light reflector fittings for platform lighting with anodised aluminium reflectors and upper opal glass casing.

(3.4.) Avoidance of Deterioration Due to Adverse Atmospheric Conditions

There is a respect in which certain railway premises—principally locomotive sheds and yards—are unique, viz., the extraordinarily adverse atmosphere produced by the combination of soot and sulphurous fumes with the moisture due to condensation. The deterioration that takes place—and often very rapidly—has to be seen to be believed. There are parts of the roof of an ordinary locomotive shed that have to stand up to what is equivalent to a bath of corrosive acid.

(4) Special Problems

Quite apart from the general requirements noted above, there are naturally a number of special problems which arise in the various sections of railway working. These may conveniently be dealt with under the following heads:—

(1) Locomotive depots
(2) Goods sheds
(3) Shunting yards
(4) Signal cabins
(5) Lighting of stairways.

Many of these problems are similar to those arising in ordinary factory work, but perhaps made somewhat more difficult by the adverse conditions present in railway working. There are also many personal problems, for example, the difficulty of satisfying all the men in a number of separate shifts. It is so easy to get a system of lighting in a signal cabin which is satisfactory for all the workers except one, who may wish to insist on his special idiosyncrasy.

In exterior lighting the problem most frequently met with is that of finding suitable sites for posts or towers on which to provide lighting apparatus

without interfering with shunting work or without involving almost impossible alteration to the existing lay-out in sidings.

There are also problems of office lighting, where again the personal element is of considerable importance, but though experience has thrown some interesting light on these problems, they are not, strictly speaking, railway problems and are rather outside the scope of the present paper.

There is often a tendency to regard lighting as something that can be superimposed on premises after structure and equipment have been settled, with a result that many problems, ostensibly connected with lighting, really boil down to such questions as a rearrangement of furniture in a room or a different construction of a skylight, etc.; all pointing to the fact that lighting is bound up with the original design of premises and should not be regarded as a separate item to be dealt with at a later date.

Fig. 3. Fluorescent tubes built into the walls of a locomotive inspection pit.

(4.1.) Locomotive Depots

Anyone who has spent some time in a locomotive shed of the usual type realises at once that the primary lighting problem is one of fighting the adverse atmospheric conditions already referred to. There is often in addition an all-pervading fog which no amount of candle-power will fully penetrate.

Smoke troughs are usully provided to carry away the excess of offensive output from locomotives, but unless an elaborate system of forced ventilation is provided these troughs have, in certain weather conditions, very little effect. The lighting engineer has to make up his mind that the enemy is always lying in wait and has to design his installations accordingly.

Special extra-robust fittings have been submitted by designers, but even manufacturers with wide experience have been amazed at the way in which reflecting surfaces, guaranteed untarnishable, deteriorate markedly in a week or two.

The roof of an engine shed naturally has anything but a good reflection factor, and this makes it usually desirable to provide some sort of downward-directing reflector, but difficulties with corrosion and the need for incessant cleaning have led us in some cases to abandon altogether the idea of reflector fittings and to use simply bare lamps in porcelain lamp holders.

(4.1.1.) *Inspection pits*

One of the problems of the locomotive shed is how best to light the inspection pits provided for the examination of engines from below. Here again the adverse element is always present, particularly an accumulation of oil and a sort of mud that is formed after the washing out of engines.

In the past, the method usually adopted for lighting these pits has been

the employment of hand lamps with flexible connections and, on the grounds of safety, these hand lamp installations are gradually being adapted to a low voltage supply. In fact, there are many purposes in a locomotive shed for which a low voltage supply is required on the grounds of safety, and it may be assumed that such a supply is always available in up-to-date sheds.

Recently a scheme of fluorescent lighting for inspection pits has been tried on one railway, and has proved to be almost ideal from the point of view of illuminating the under gear of the locomotive, but it is perhaps early to say to what extent maintenance difficulties have been overcome. (Fig. 3.)

In this case the inspection pit was constructed of pre-cast concrete sections, each 6 feet in length, and each section was constructed with a prefabricated recess for the fluorescent tube equipment on one side and a through duct for cabling on the opposite side. When the sections were assembled to form the pit, they were fixed with the fluorescent tube recess alternately one side and the other of the pit, and the alternate provision of cable duct thus enabled the whole installation to be readily wired. The tubular lamp was protected by a plate glass front flush with the wall of the inspection pit.

It might be supposed that lighting from tubes at the sides of the pit would not give the requisite upward illumination, but experience has shown that the combination of direct illumination and cross illumination by reflection gives an excellent effect, so long as the walls of the pit are maintained reasonably clean.

(4.1.2) *Locomotives under repair*

In the design of some modern locomotives provision has been made for self-contained electric lamps to light important working parts. Another development, giving more adequate lighting for repair work on engines, is the adoption of a form of trolley which can be readily wheeled close to the side of an engine where, for example, a valve movement might require inspection. On the trolley is mounted one fixed fluorescent tube at about eighteen inches above the ground, and, at a considerably higher level, a swivelling arm carrying a second fluorescent tube capable of being brought by a simple control to any particular level or angle required for the close inspection of the engine.

As the trolley is fed from the 50-volt supply, a step-up transformer is employed to give the normal voltage for the purpose of serving the two fluorescent tubes. (Fig. 4.)

(4.2.) Goods Sheds

It might be supposed that there are no special problems in goods sheds, seeing that they consist mainly of large floor areas roofed over in a normal way much as in the average factory. It is true that well-distributed general lighting is the main requisite, and in some of the more modern and mechanised goods sheds with lofty roofs the lighting installation presents no difficulties. (Fig. 5.)

(4.2.1.) *Box wagons*

There is, however, a problem that is very commonly encountered in the lighting of the interiors of covered-in trucks, or box wagons, as they are usually called. Undoubtedly, whether for loading or unloading, the interiors of these box wagons should be individually and properly illuminated. Yet, in the past, there has been a tendency to make do with stray light entering from the side door of the wagon. In some cases the design of the shed lighting has been so arranged that a fair proportion of light has been directed by angle reflectors

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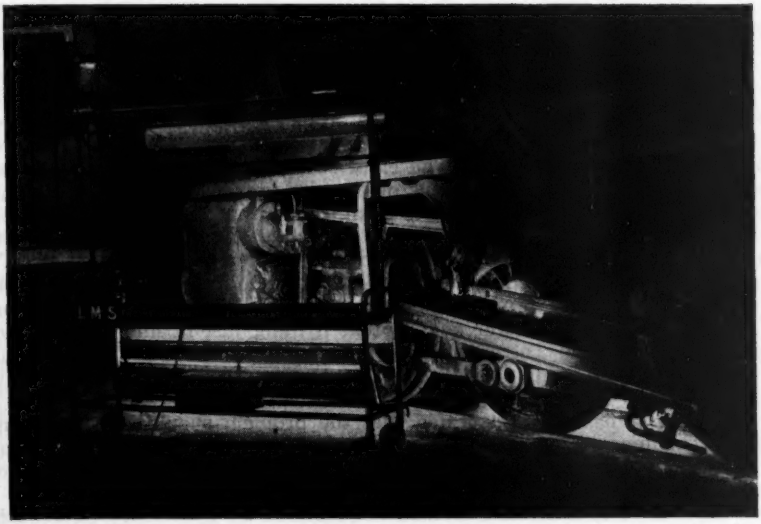

Fig. 4. Fluorescent tubes mounted on trolley with adjusting gear for close inspection of valve motions, etc., on locomotive.

Fig. 5. Typical general lighting from roof fittings in modern mechanised goods warehouse.

so spaced that one occurs roughly opposite each open door. (Fig. 6.) This, of course, depends to some extent on the wagons being of approximately the same dimensions and their being berthed always more or less in the same positions in the shed.

Another device that has been adopted where electric lighting is available is the fixing of plug points flush with the edge of the platform, into which can be plugged portable lamps with cab tyre protected leads, and these lamps can be temporarily hung inside the box wagons and can be transferred as work moves along the loading dock. The chief objection to this type of lighting is the risk of damage to the apparatus due to the rough handling that is almost inevitable when very rushed work is being carried out.

A further method of using electric lamps for lighting interiors of the wagons was tried some years ago with a certain amount of success. Two strained wires were stretched, out of ordinary reach, along the line of the platform, and from these bare wires hung an insulated bar with a lamp and angle reflector attached at its lower end, so that it hung just in line with the door opening of the wagon. The connections were wired from hooks to the terminals of the lamp and the hanging device could, of course, be fixed anywhere on the strained wires.

Recently it has been suggested that the problem should be treated in a different manner. Why should the box wagon be made entirely of opaque material? In the past the answer may have been that glass in the roof would not stand the strain of shunting and rough loading, but surely in these days there is a suitable translucent material of practically unbreakable character which could be used to form the greater part of the roof of the wagons. If wagons were so constructed the problem of lighting would be greatly eased. During the day they would obtain natural light through the glazed roofing of the shed in which they were used, and at night the artificial

Fig. 6. Lighting of transit shed by means of angle reflectors to direct light through door openings of box wagons.

lighting directed downwards from the shed roof would still illuminate the interiors of the wagons, almost irrespective of where they happened to be standing, provided the distribution of lighting was reasonably uniform.

(4.2.2.) *Van docks*

The lighting of van docks, especially where vans are backed into recessed openings in a shed, presents some difficulty because of the absence of any standard in the types of vans or lorries. One of the simplest ways of dealing with this is the provision of portable standard lamps mounted on heavy bases. These can be placed exactly where required and they involve a minimum of flexible lead for the current supply.

(4.2.3.) *Checkers' desks*

In most goods sheds an important part of the work is carried out at the loading or unloading bank where waybills or consignment notes have to be checked. This is usually done at checkers' desks which should have an exceptionally high quality of lighting, bearing in mind that records in copying ink, sometimes on coloured papers, and frequently on a shiny surface, are often very difficult to decipher. This seems to be a case where fluorescent tube lighting should be applied and such installations are actually in hand.

(4.3.) Shunting Yards

The fundamental problem in a shunting yard is to light adequately the shunting "neck" and the sidings that "fan out" from beyond this point and are controlled by successive point levers. The basic case may be shown in a very simple diagram. (Fig. 7.)

(4.3.1.) *"Hump" shunting*

In modern large shunting yards, the old method of pushing off a single wagon with a propelling thrust and then drawing back to push off another down a different siding has given place to hump shunting. In this case a succession of uncoupled wagons are propelled to the top of a sharply marked hump formed artificially at the shunting neck, and as each wagon arrives at the top it runs forward under gravity and can be switched into any of the sidings that fan out below the hump. The points have, of course, to be worked mechanically and their control is centralised in a tower with a form of switchboard or control desk under the window. The controller, observing the wagons as they pass, notices a number chalked on the end of each wagon, indicating to him the required siding.

It will be noticed that, although there are special demands for local lighting to give a clear delineation of the chalk numbers on the wagons, the lighting problem in both the new and old shunting yards is that of indicating clearly the whereabouts of the wagons, and especially whether they are clear of the siding next adjacent to that in which they have been shunted. It has been common practice in the past to fix a lamp on a post as close as possible to each pair of points, without impeding the freedom of shunters to move backwards and forwards in their recognised walk-way. This light enables shunters to be certain which way the points are set, but it does not so effectively indicate whether a wagon has passed sufficiently far along the new path as to be clear of the road just left. In daylight this important decision may well be left to the judgment of the shunter, but at night it becomes extremely important to

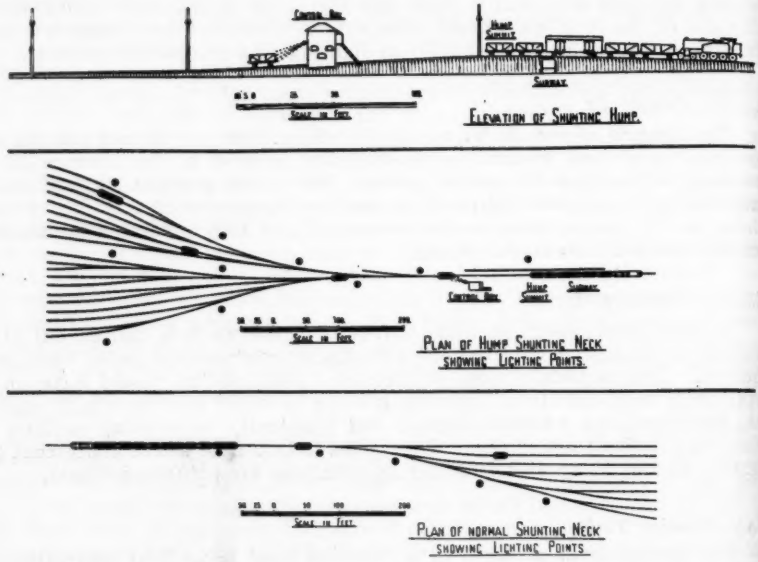

Fig. 7, Diagrams of typical layouts for shunting yards.

have good illumination on the vertical surface at the end of a wagon so as to assist in judging its exact position in relation to the tracks.

(4.3.2.) *Background illumination*

Whatever scheme is adopted for special local lighting at the places where shunting is concentrated, it would undoubtedly be advantageous in expediting movements if a general background illumination were provided over the whole area. Where such illumination is not provided—in the great majority of yards—the operating staff are bound to move frequently from well-lighted to insufficiently lighted areas and they often have to rely on hand lamps to reveal obstructions. There is little doubt that shunting movements are dealt with more expeditionsly in daylight than after dark and so long as this is so the lighting engineer cannot pretend that he has fully carried out his task.

Attempts have been made in U.S.A. to improve conditions in shunting yards by flood lighting from high towers, but it is not clear whether this has given quite the quality of illumination required for a safety background. In order to test the effect on shunting operations of producing something akin to a magnified moonlight, a trial was made of high elevation lighting by suspending a lighting unit from a barrage balloon at about one hundred and fifty feet above ground. The first reactions to this lighting were generally favourable, and it is now the intention to install something of a permanent nature, which might take the form of a light steel mast surrounded by a ring-shaped lighting fitting. This fitting would be designed to rise and fall by means of a winch, thus enabling maintenance to be carried out without climbing the mast. Such a design would also permit of the fitting being lowered in case of foggy weather, although it may be remarked that dense fog seldom occurs

below one hundred and fifty feet unless it is so widespread as to stop all shunting.

The minimum intensity of illumination at ground level which it is thought will be afforded by this system from a high elevation is of the order of 0.075 foot-candle, and the aim would be to secure a diversity of not more than about 5 to 1 in the main working areas. Further trials which it is anticipated will be carried out in the near future will show to what extent such background illumination is worth the expenditure involved. It is not at present contemplated that this would displace all ordinary yard lighting, but it would greatly reduce the number of lighting poles by limiting these to those sites where intensified local lighting is essential.

(44.) Signal Cabins

In considering the lighting of signal cabins it is well to bear in mind the difference between those that are power-operated, in which case they are supplied with illuminated diagrams controlled from the track to show train movements, and those of the ordinary lever type, manually operated. Although the number of power-operated signal cabins is increasing rapidly, the great majority of the cabins in this country are still of the ordinary signal lever type.

Fig. 8. Signal cabin lighted with opaque reflectors and low-candle-power lamps to reduce brightness.

In this latter type, the ability of the signalman to see through the windows of the cabin what is going on outside is of vital importance. For example, he may have to follow the movements of steam shunting operations, or he may observe a passing train to see that rear lamps are in order and that no door is swinging open. In the earlier systems of lighting signal cabins there was difficulty in seeing through the windows because of the reflected images of the lamps inside, but there has been a tendency of recent years to pay more attention to this question, and an endeavour to obtain a reasonable "dark adaptation" vision for the signalman, by avoiding as far as possible any disturbing reflections of lighting fittings, either in the windows or in the glazed fronts of diagrams which may be fixed behind the signal frame. In deciding on positions for lighting fittings allowance has to be made for the different angles of view due to varying heights of signalmen and also to their movements from one part of the lever frame to another.

A result of recent investigations has been to specify maximum illumination values rather than minimum values, and now the general aim is to keep signal boxes as dim as possible consistent with clear vision of the working frame, of diagrams and indicators that must be clearly seen, and at the desk at which trains are booked. It has been found possible by means of local screening of lights to eliminate almost entirely reflections in the main windows of the signal box and yet to provide a sufficient degree of illumination at all vital points to enable the signalman to work without destroying the partial

"dark adaptation" of his sight, so that he is able to turn quickly to the window and see without difficulty any movement outside. (Fig. 8.)

Indirect lighting has been used, but the difficulty of maintaining a good reflecting surface is a serious handicap to this method. Flush and semi-flush ceiling lights have been adopted when a flat ceiling is part of the design, but even with well-diffused lighting from large surfaces of comparatively low brightness, there is a certain amount of distracting reflection in the windows.

(4.5.) Stairways

Although the problem of stairway lighting is not peculiar to railways, the conditions are exceptionally varied and extend over a wide range, from times when stairs are so closely packed with passengers that it is quite impossible to see the treads clearly either by natural or artificial light, down to the other extreme when only a single passenger may be using the stairs. Contrary to what might be expected, experience shows that accidents on stairways are more frequent when traffic is light than when crowds are using the stairs. This may be due partly to the fact that a crowd slows down the rate of movement and also that, when moving in a crowd, a passenger is guided by the movement of those just ahead. It is found that accidents most commonly occur to individuals passing singly down staircases and they are in very many cases due to hurrying for a train.

It must always be remembered that, in a miscellaneous collection of people such as the normal crowd either on a railway or in any other public place there are bound to be many with defective eyesight or infirmities which render them particularly susceptible to mishap. It is surprising how seldom people avail themselves of the safeguard provided by the handrail which exists on all public stairways. Especially when stairways are wide, passengers would seem to think it *infra dig.* to move from the centre to the side, in order to grasp the handrail.

The main features which govern the satisfactory lighting of stairways appear to be the following:—

(1) The need for contrast between the front edge of a tread and the remaining portion of the tread. Also (to prevent confusion in ascending) there should be contrast between treads and risers.
(2) Avoidance of glare from the light sources.
(3) Avoidance of any confusing cross shadows.

With regard to the first, experience shows that this is by far the most important feature, and it has been found that, with an absence of the necessary contrast, no amount of care in providing either maximum brightness or maximum diffusion from the light sources will render the stairway safe from mishap.

If the nosing of a tread and the tread itself are all of one uniform colour and brightness, it is obvious that, when viewed from above, the nosing of the tread will not show up against the similar background provided by the next tread and the result is that the stairway appears to be a uniform slope. The problem of providing the necessary contrast is a difficult one because of wear and tear and dirt. The obvious solution of providing a white nosing is negatived largely because, in bad weather, dirt almost neutralises the effect. If the contrast is obtained by a darkened nosing, there is always the risk that the remainder of the tread will gradually get sufficiently dirty to match up to the darkened nosing. One of the most promising devices seems to be the provision of a very hard nosing, either of bright metal or of a gritty form of tiling, so that the natural wear of the nosing keeps it always of a lighter colour

than the remainder of the tread. The contrast referred to is, of course, just as necessary for natural lighting as for artificial lighting and that is another reason for attaching special importance to this feature. A good example of contrast between nosing and tread may be seen in the stairs connecting Waterloo Bridge with the Embankment.

The second item, although of secondary importance, is a matter that must not be neglected, owing to the obvious interference with the perception of the treads if the eyes are confused by glare. The matter is dealt with quite clearly in paragraph 27 of the I.E.S. code and there is no need for the point to be elaborated here.

The third item is also an obvious requirement and is only mentioned because sufficient care is not always taken of this point, although it should be axiomatic to a lighting engineer. The desire to combine the lighting of the stairway with the illumination of some feature such as an advertisement board sometimes gives rise to irregularities on stairways. It is thought that many irregularities in lighting arise from such attempts to economise by using lamps jointly for two separate purposes. The gradual adoption of better standards should tend to eliminate these cheeseparing methods, and the faulty lighting arising from them.

The placing of lamps in relation to stairways is important and experience indicates that the general direction of lighting should be from behind the passenger descending the stairs, so as to throw a shadow of the nosing of a tread on to the next tread below, the contrast between the dark shadow and the remainder of the tread which is illuminated producing a clear indication of the edge of the tread which it is so vital to see clearly. The mere provision of high candle power above the stairs is not in itself a solution, if the requisite contrasts are not provided. In fact, a fairly low intensity, coupled with absence of glare and good contrast, has been found to be very satisfactory for giving clear visibility.

A scale model of a stairway which has been built in order to demonstrate some of the points mentioned is illustrated in Fig. 9.

An experiment tried out on the model was the possibility of rendering the treads more readily visible, in conditions of crowding, by providing understair lighting. A high brightness cannot be permitted in this method of lighting because of the confusion that would arise in ascending the stairs with brilliant risers directly in the line of vision. A satisfactory effect is obtained if the top lighting is reduced below what we are used to, in order to throw into relief the lighting of the treads. Any such system would, however, be costly to install and maintain in good order. It is doubtful whether it could be justified except possibly for a stairway in which exceptional crowding occurred.

Fig. 9. Lighting of model staircase showing contrast of treads.

(5) [Possible Future Developments

It is fairly certain that there will be improved quality of illumination as well as increase in the general level of lighting values adopted in all departments of the railways. This is only to be expected, as railways are not likely to fall behind other industries

in the general trend towards better and brighter lighting. (See Figs. 10 and 11.)

The fluorescent tube has set up a new standard in respect of the quality of light, and it is this feature of special quality which should be stressed rather than the less obvious economy in running costs. To secure a reduction in annual cost demands certain conditions which are not always present, whereas the special qualities of diffusion, low brightness and good colour are most valuable assets for many cases where there is difficulty in providing adequate light by tungsten lamps.

Many of the problems met with in railway work may be solved by the use of fluorescent tubes. Clerks serving in public enquiry offices have a severe visual task in constantly referring to time tables, and in the invoice office of a large goods depot a good deal of eye strain is liable to occur when cross references have to be made to tables of special charges propped up in front of a clerk at a desk. The strain is accentuated by the necessity of speedy work so as not to delay the departure of trains. Many other examples could be given, and attention may be drawn, in passing, to experiments that are being carried out in the application of fluorescent tubes to passenger coaches, which should give a much better reading light than has hitherto been enjoyed. These experiments, however, relate to rolling stock and are outside the immediate experience of the authors, whose field is confined to "static" lighting.

(5.1.) Future Developments Affecting Comfort and Safety of Passengers

In addition to the general improvement in the lighting of waiting rooms, booking offices, enquiry offices, etc., which was already in evidence before the war, the possibilities of development may be conveniently grouped under the following headings:—

(1) direction signs
(2) station name signs
(3) train indicators and time table boards
(4) safety lighting on platforms and stairways.

(5.1.1.) *Direction signs*

The London transport board has set a very high standard in the arrangement, display and lighting of direction signs on the tube railways, and it would almost seem that in some directions finality has been reached. When the utmost care has been taken to direct passengers clearly, there will always be that type of passenger who, confronted with such clear directions, persists in a verbal enquiry.

The lighting engineer can hardly be of much assistance in such cases, but nevertheless it is probable that there will be an increasing tendency to illuminate all signs of real importance in the guidance of the public. What form are these signs likely to take? For the sake of permanence and ease of maintenance there is a leaning towards enamel plates, but these are not any too easy to light effectively and it may be anticipated that some use of glass or plastics will be made in which the illumination is inherent in the design. The Society has already had brought to its notice some ingenious signs, e.g., those devised by Beutell and Ruthven Murray, and we may look forward to further developments of this kind as well as to improved designs in box signs.

Clocks may be regarded as equivalent in some respects to signs. It is hoped that the future will see a larger number of station clocks, preferably multi-face clocks wherever possible, illuminated internally. The modern use of dials with black dots spaced at intervals of 30 deg. round the circumference

Fig. 10. Cold cathode fluorescent tube lighting on No. 8 platform at Victoria Station (S.R.)

Fig. 11. Cold cathode fluorescent tube lighting at Malden Manor Station (S.R.). White lighting produced by two lines of tubes of complementary colours.

may have advantages for distant view (as on the Shell Mex building) but they set an unnecessarily severe task for the lighting engineer and an illuminated white opal background is hard to beat for clear visibility at night. Such dials, with the usual synchronous electric drive, would give the public the best possible facilities.

(5.1.2.) *Station name signs*

It was an old Board of Trade regulation, and has been a tradition of railway practice for many years, that each lamp lighting a platform shall exhibit in some form the name of the station. This very excellent rule has tended to lapse to some extent owing to the adoption of modern methods of illumination. We may ask what constitutes a "lamp" if a platform is lighted by long strips of cold cathode tube in 9-ft. lengths closely abutting one another, and other methods may be adopted that will diverge completely from the established idea of "lamps." Of course, the exhibition of the station name can, under modern lighting, be arranged anywhere and it is simply a question for the expert on sign display to decide at what distance apart the names should be spaced. Enamel plates, preferably with some target feature to distinguish them from advertisements, appear to be most suitable, and they are equally effective both by day and by night if proper consideration has been given to the lighting.

Fig. 12. General arrangement of lamp fitting incorporating station name.

It is probable that we shall see a multiplication of small name signs closely spaced along the back of each platform so that from any part of a standing train the name of the station can be easily read. These signs will not need any special illumination provided the general brightness is up to a modern standard and is uniformly distributed. Whilst this presents no difficulty under a station roof, it must not be forgotten that there are still many stations where a considerable proportion of the platform is unroofed and some special designs will be required for these. In any case the small name signs referred to will no doubt frequently be augmented by illuminated names of a more pretentious type. A name sign, incorporated in the lighting fitting, is illustrated in Fig. 12.

All kinds of devices for illuminating station names have been tried in the past, including box signs of many kinds, and it is likely that these will be revived in order to make the station name conspicuous, but the requirements of easy maintenance lead rather to the use of enamel plates lighted by ordinary lamp fittings as the staple method. (Fig. 1.)

Passing reference may be made to the illuminated name boards with special large lettering which were fixed at a number of Southern Railway stations before the war These were spaced well away from the track where they were easily visible to anyone looking out of a window and they elicited a good deal of favourable comment. Many of these have had to be abandoned for a reason that shows the influence of passenger safety on such matters. When the sites for the name boards were first fixed, special care was taken to see that they were not in a position where they could be seen if a train were pulled up at

the home signal, just outside the station, because a lighted name might lead passengers to assume that the station had been reached, causing them to attempt to alight where no platform existed. It so happened that a change of signal positions brought about by the colour light signalling system rendered several of these name boards misleading as just indicated and they had to be dispensed with.

(5.1.3.) *Train indicators and time table boards*

Before considering illumination problems in connection with indicators for arrival and departure of trains, it is well just to go over the main requirements. A train departure indicator must show:—

(a) The time of the train;
(b) What stations it serves;
(c) The platform from which it leaves.

A fully comprehensive indicator at a terminal station or an important junction may be rather complex, and as it is essential that it can be read easily from a reasonable distance either by day or by night, the lighting, both natural and artificial, being of considerable importance, should be borne in mind at the time the indicator is designed.

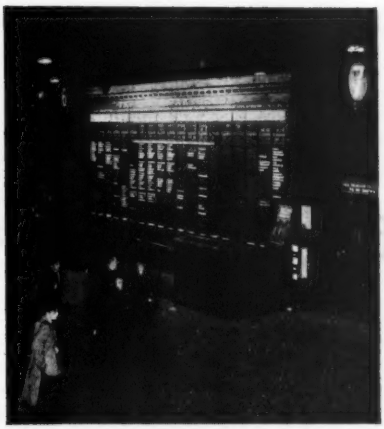

Fig. 13. Typical train departure indicator lighted by tungsten lamps in angle reflectors.

It is mainly a problem of display of lettering and figures, and, for reasons of upkeep, it has generally been found that enamel plate forms the best surface. This at once points to the necessity of care in arranging the lighting so that there are no images of the lighting fittings reflected from the enamel surface and causing illegibility. (Fig. 13.)

For train indicators it is hardly possible to light from behind, owing to the need for mechanism in changing the display of stations served by a particular train. It is more feasible to light internally the platform number and the train time, but this leads to a rather complicated design and is probably not worth the elaboration.

A scheme has been devised for displaying the information on an indicator in fluorescent material, so that this can be stimulated by ultra-violet lamps. In air-raid conditions, when a high degree of illumination was barred, the effect obtained was very good, but it is doubtful whether the method can be regarded as feasible in ordinary conditions of lighting.

Besides improvements in the illumination of general train indicators there is a wide field for some simple illuminated indication at each platform gate. This may take the form of an illuminated sign much as the front destination board of a 'bus or tram, with rollers to vary the display, but a method that is much favoured on account of its simplicity is the provision of a sort of sign post from which a detachable arm projects.

The lighting problem in this case is simply the provision of a brightly lighted

field in which both sides of the board appear well lighted. Probably, in future it will be convenient to combine this with the necessary light for the ticket collector at the gate, by providing an overhead inverted trough with fluorescent tubes. (Fig. 14.)

The lighting of time table boards does not present any special problem except that the train times are usually in rather small type, and most observers tend to get close up to the time table in order to read it comfortably. This may give rise to awkward shadows unless the lighting is carefully planned. One of the most satisfactory methods is to illuminate the time table from behind. For this purpose it is desirable for the printing to be done on extra quality paper and for the sheets to be placed between glass plates. Then it is simply a question of fixing bare lamps in the box behind the displayed time table and adjusting the number and candle-power of the lamps so as to give just the requisite brightness without any trace of glare. The double-sided time table boards in use at Waterloo and some other stations on the Southern Railway are illustrated in Fig. 15.

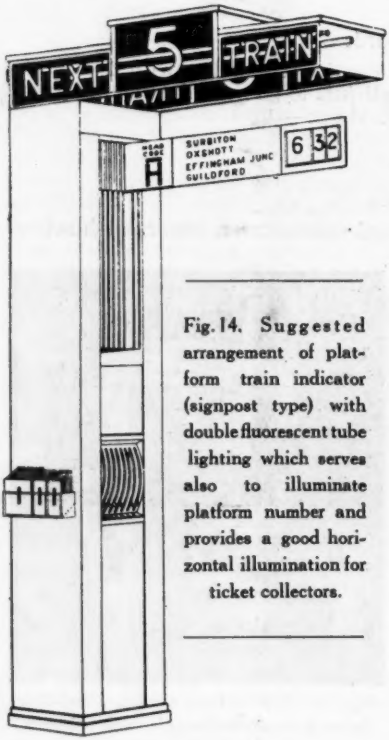

Fig. 14. Suggested arrangement of platform train indicator (signpost type) with double fluorescent tube lighting which serves also to illuminate platform number and provides a good horizontal illumination for ticket collectors.

Whether illuminated time tables are likely to form a common development in the future is somewhat doubtful, as there is a feeling abroad that these time tables are used by such a small percentage of passengers as to make them of relatively small importance. It is thought to be more useful to concentrate on providing a really good bureau for personal enquiry.

(5.1.4.) *Safety lighting on platforms and stairways*

The most probable development in platform lighting seems to be in a greater diffusion of the light so as to avoid alternations of light and dark patches. This has already been shown to be possible under roofing by the use of continuous tube lighting, and it should not be beyond the capacity of illuminating engineers to secure a much greater evenness of light distribution on the parts of platforms that must for economy reasons remain open to the sky. Alternatively, watertight lighting troughs might be incorporated near the edges of platforms as an auxiliary to the usual lamp posts. Of course, any such scheme would represent a very appreciable increase in the cost of a station, both initially and annually, but why should not the lighting of a station be one of the major considerations in its design. When it is so regarded there will be more readiness to treat the cost as an essential item and not as something on which down-

Fig. 15. Time tables mounted between glass plates and illuminated from behind.

ward adjustment can always be made if other items have exceeded the anticipated expenditure.

So far as stairways are concerned, these have already been dealt with in some detail and it is thought probable that developments are likely in special stairway lighting where a good deal of crowding takes place, so as to reduce as far as possible the number of mishaps. In attempts to light for safety it is not sufficient to try and imitate daylight conditions as the eyes of passengers are undoubtedly differently adapted in night conditions and artificial lighting should be considered entirely on its own merits. It must not be forgotten that artificial lighting is often blamed for mishaps due to quite different causes and such as would have taken place equally in daylight.

(5.2.) Future Developments Affecting Welfare of Staff and Efficiency of Operation

It is a truism that the two elements in the above heading are closely linked and the modern tendency to afford improved amenities for staff is bound eventually to lead to greater efficiency in working. It is, however, convenient to consider the two matters separately.

(5.2.1.) *Lighting and staff welfare*

There will undoubtedly be a rapid improvement in the lighting provided for staff rooms, as part of the general move for better amenities. In a recent report of an inter-railway committee on improved conditions, reference was

made to the I.E.S. code and the standards therein laid down are recommended as being suitable for railway authorities to work to. In view of the development of new lighting fittings which we feel is near, no attempt can be made to forecast the exact direction in which improvement is likely to take place, but it is certain that more attention will be paid to quality of light and there will be less tendency to gauge everything by the cost of current. It is to be hoped that in the new fittings to be introduced the importance of simplicity and easy maintenance will be fully recognised. Until they are rather freer of accessory items, fluorescent tubes are not likely to be used much for staff rooms, but the point may be emphasised that in the case of staff working under adverse conditions—underground shelters, permanent artificial light, etc.—fluorescent lighting has already proved invaluable.

(5.2.2.) *Lighting and efficiency of operation*

Under this heading there is undoubtedly a wide field for further research. Whilst many of the straightforward railway operations merely require ample light of good quality, it has already been shown that there are very definite problems connected with such places as locomotive sheds and shunting yards. It is in these directions that we may look for future developments, with a more positive attempt to overcome the difficulties under which the staff work.

The railway general managers have shown themselves ready to authorise expenditure on improved lighting, the railway staff are keenly alive to the advantages of such improvement and the lighting engineers know what is wanted. All that remains is for material and labour to become plentiful and the job will be done.

The authors are indebted to Mr. Masterton of the photographic department, Southern Railway, for his assistance in the preparation of the slides and to Mr. V. A. M. Robertson, Chief Civil Engineer, for permission to publish the paper.

Discussion

Mr. A. R. McGibbon, remarking that it was rare for the Society to have a paper on railway lighting, said this paper afforded an opportunity for members, who were also customers of the railways, to have a peep behind the scenes and obtain some idea of the problems confronting the railway lighting engineer. It further afforded an opportunity for members to throw a few good-humoured brickbats at the railways. On the other hand, if there were any bouquets to be thrown he thought they should be thrown at the authors, who certainly deserved them—and there might not be another opportunity of doing so before January 1, 1948! For some reason it was not customary to present bouquets to State enterprises—however good they might be.

Continuing, he said that through the Railway Clearing House there existed close co-operation between the railway companies on lighting matters. While there was agreement on general standards, each company solved its own problems in a way best suited to its own conditions—a method which tended to lead to progress and development of new methods.

But there was one problem common to all railways and public bodies, and that was the problem of theft and wilful damage by a comparatively few "hooligans." The theft of lamps or damage to installations frequently resulted in the minority causing the majority to suffer. The theft of lamps, for example, was very considerable, particularly, strangely enough, the theft from steam trains of 24-volt lamps, which were quite useless for domestic purposes.

The authors had mentioned engine sheds where the corrosive conditions

were appalling, and really had to be seen to be believed. Some two or three years ago his company (L.M.S.) started to modernise a large number of engine sheds, and included a relighting programme. As a result of his experience, he could quite understand the decision of the Southern Railway to scrap all reflectors, as they corroded away, and to make use of bare lamps in porcelain holders, although he thought there would have been some difficulty with corrosion of the metal parts of the lampholder itself. He thought the complete absence of reflection from surrounding surfaces would have resulted in excessive glare. In the case of his own company, it was decided to adopt a cast-iron fitting with an acid-resisting vitreous enamelled surface, the reflecting surface and lamp being protected against dirt by a glass vizor. They had pinned their faith to that design and felt they had done the right thing. The reflector gave a 15-deg. cut-off which to some extent dealt with the question of glare.

The lighting of marshalling yards provided a problem which had not yet been solved. Some people thought that the street lighting technique could be applied to these yards, but he felt that the yard surface was far too dark, frequently consisting of ashes, from which there was no high brightness as in a street, to compensate for the glare from unscreened lights having high intensities near to the horizontal. The authors' experiment with the barrage balloon had called for a good deal of courage; it was a magnificent experiment which he had been very pleased to have the opportunity of seeing. The "magnified moon" gave a most peculiar effect and provided a new development; he was very pleased to hear that further experiments were to take place, as he thought this method showed a good deal of promise.

As regards time-table lighting, he agreed that to sandwich the time-table between two pieces of glass and light it from behind was the most effective arrangement. Any system in which the cover glass was offset from the surface of the time-table prevented one from tracing with the finger across the sheet. He had found the fluorescent lamp useful in this connection; in one case it had been possible to replace a dozen small lamps by one 80-watt fluorescent lamp. The bluish whitness of the light enabled ordinary poster paper to be used.

He had listened to a most interesting paper and looked forward to an enlightening discussion.

Mr. M. G. Bennett said that as the author of one of the earlier papers on railway lighting it was interesting to him to compare the past with what was now going on, and to comment on the advances that had been made, and the problems still remaining to be solved. A number of the problems to which he had referred ten years ago had now been solved, the fluorescent lamp having greatly assisted in that respect. There had been great improvements in the lighting of the valve motion of engines and in the lighting of the under-side of engines and cars from pits. The fluorescent lamp was also being used for the lighting of control rooms, etc. The paper had also indicated the developments that had taken place in the lighting of marshalling yards, etc. He rather felt that lighting engineers were getting away from talking of the foot-candle and were thinking of the quality of the lighting, because the level of illumination was now beyond the minimum necessary for vision and was approaching the point at which quality was more important than quantity. He felt, however, that they were still concerned with silhouette lighting for marshalling yards.

As regards lighting yards from high up, high masts were used on the Continental railways, but difficulties arose in a fog which blotted out everything, and it was then necessary to rely on such local lighting as there might be

available. Nevertheless, there were advantages in having the lighting high up when there was no mist about.

Another problem not yet solved was the lighting of covered wagons in the goods sheds. He thought the solution suggested might be possible from the theoretical point of view, but it would take a long time to achieve.

The question of shades in engine sheds has gone through many fashions; inverted shades, mere lampholders, skirted lampholders, hermetically enclosed fittings, and almost everything else has been tried without complete success. There will be no ideal solution until the corrosive atmosphere in the engine sheds is got rid of.

In conclusion, he said he thought a comparison of the authors' and his own earlier papers showed a record of considerable progress in the past ten years.

Mr. P. S. BARTON said the experiment with the barrage balloon was the first practical experience of lighting from a considerable height, and although the authors had not said whether the lighting was good, bad, or indifferent, it must have been reasonably successful otherwise it would not have been decided to go farther with the experiment. Nevertheless, it would be interesting to know to what extent it was satisfactory. He would also like the authors' views with regard to the lighting of marshalling yards in fog, quite apart from the balloon idea.

As regards the lighting of station names, unless one was a regular traveller on a particular line, it could not be said the public was well served in this respect. At small, wayside stations the porter usually called out the name, but at the larger stations the traveller very often did not know where he was. There was also the question of better lighting of destination boards at the large stations, and he thought there should be large, well-illuminated signs showing the destination of the trains starting from the platforms. At present it was too often the case that the destination boards were small and dirty and very difficult to read.

Mr. E. W. MURRAY, referring to signal-box lighting, said he could see similarities between this and picture gallery lighting. Was it not possible to arrange the lighting so that the operator stood in a more or less dark area in the centre of the box where he could not see any reflections of lights. Such a scheme was used in a picture gallery where, in viewing the pictures, the observer stood in the dark and could see the picture without seeing his own face or collar reflected in the picture glazing. This could be arranged by indirect lighting above a canopy large enough to cover the operating area of the signal-box and high enough for the man to stand under it.

Further, would it not be possible to make use of weak blue illumination and so take advantage of the increased sensitivity of the eye at such illumination levels. Alternatively, it might be possible to provide such a contrast using blue colouring on the objects which have to be seen whilst the signal-box is illuminated to a low level, say, 0.2 ft.c. or under, by indirect lighting.

On the subject of staircase lighting, he was of the opinion that with any normal flight of stairs, which are regular as regards height and width of tread, no special care is needed from the illumination standpoint. It was important that the first step and end step be clearly visible, which, of course, means illumination with suitable colour contrasts. But with long uninterrupted flights of stairs, such as exist on deep escalators, the illumination, away from the positions where one stepped on or off, was unimportant. The levels of illu-

mination taken on such long flights of stairs are instructive from this point of view and they were found to be 2 to 3 ft.c. at the top and bottom and for about 80 per cent. of the length of stair 0.01 ft.c. and under. When the stairs were crowded the level of illumination was under 0.002 ft.c. in those areas away from the beginning and end of the escalators.

In the case of wide staircases he was inclined to think that the provision of hand rails not more than two feet nine inches to three feet apart would reduce the risk of falls to a minimum. The majority of accidents arose on wide stairways with insufficient hand rails. This was particularly noticeable in the cases where at the bottom of a flight of stairs one turned to go to the right or left. With few people travelling one started to walk diagonally across the stairs from about the sixth to eighth stair up, and with the male population with turn-up trousers the inside of the heel of the shoe or boot of one foot caught in the turn-up of the other trouser leg and a stumble resulted. A hand rail within reach would prevent the stumble by eliminating the desire to travel diagonally across the stairs. No illumination scheme could reduce this sort of risk.

Another risk was the distraction by advertisements on the sides of stairways—a very large and simple advertisement, which could be taken in at a glance, might be all right, but something that needed more than a momentary glance would in all probability so distract the person, who tried to descend and read at the same time, as to cause him to stumble. He thought it was remarkable how easily persons travelling downstairs were, in a measure, put off their "stroke." One might think of all sorts of irrelevant things whilst descending, but as soon as one started to think of the stairs or look at them without stopping one lost one's balance, and, as a consequence, fell. Again, it was the hand rail and not illumination which would reduce this risk.

Variations in the height of stair treads was another cause of accident. This particularly applied to stairways which had been renovated, or a few treads had been repaired. Fortunately falls from this defect were not all serious, because they arose mainly when ascending the stairs.

In his opinion the stairways where special illumination levels were necessary were those with inadequate natural lighting. During the hours of darkness no special illumination treatment may be necessary, but in day time where the platform or other area of approach to the stairs may be sunlit to thousands of lumens per square foot it was most trying to descend stairs with an illumination level of, say, even five or six lumens per square foot. The entrance stairways to many of the underground stations suffered from this defect. The remedy was clear but costly—the rate of change of contrast must be reduced and if structural alterations to let in more daylight were not possible then additional artificial illumination to something like 40-50 lumens per square foot should be available for day time use.

Mr. J. C. Lowson, referring to signal cabin lighting, asked whether any work had been done on the use of non-reflective windows on the lines of the well-known "invisible" shop window. A simple version of the latter might be achieved by sloping the upper part of the cabin window outward and placing a matt black surface above it. This type of window might be a little more difficult to clean, but it would be protected from rain to some extent. He also asked how condensation on the windows was prevented and whether double glazing was employed. With regard to station names an illuminated sign giving a few minutes warning of an approaching station would be most helpful

at night; but an alternative solution might be to fit an audible "station announcing" system throughout the individual trains.

Good standards of illumination were becoming increasingly common in station enquiry offices and he suggested that if equally good illumination were provided in waiting rooms, it would have a beneficient effect upon the passengers' morale.

Dr. J. N. ALDINGTON, referring to the use of the bare lamp in engine sheds, suggested there would be some advantage in surrounding the bare lamp with one of the newer diffusing high transmission glasses with a smooth exterior. This would have the advantage of providing a replaceable clean over-cover and at the same time of reducing the brightness of the source. A similar problem in connection with the miner's hand-lamp has been solved by the provision of such a cover.

Commenting on the experiment with aerial lighting, he said that during the war photographs were taken from aircraft, carrying their own light source, at a height of about 2,000 feet. The authors had suggested that in their further work on lighting from a height they had in mind the use of different light sources, and they would no doubt appreciate the possibilities of the newer high-power sources of light in that connection. There was also the possibility of using the source at ground level and having a variable height reflector to deal with low mist or fog.

Mr. R. O. ACKERLEY, commenting on the suggestion of the authors that there should be a variegated edge on the platform so that passengers could see whether a train had stopped or not, added the recommendation that the edge should also be sufficiently illuminated. It was often difficult to see where the edge of the step on the train was and where the platform began. This particularly applied to those portions of the platform over which there was no canopy. A great deal could be done, also, in main terminal stations to improve the cheerfulness if there was some light on the roof. Quite a little light would go a long way to cheer people up.

One significant remark made by the authors with regard to their experiment with overhead lighting was that if the fog was sufficiently thick to interfere seriously with this form of lighting, it would also put a stop to shunting. That seemed a good point, and perhaps the authors would expand it a little.

As regards staircases, he agreed with the authors as to the importance of having a sharply defined difference between the edge of the tread and the step below, but he did not agree with the implication that was given by the authors—and had been carried even farther by Mr. Murray—that on crowded staircases people did not use their eyes. Sometime ago he had carried out considerable investigations as to how people came downstairs at Tube stations, and it was found that without exception persons looked at the stairs as they descended, in some cases continuously, in others intermittently. Therefore, the suggestion that people did not use their eyes in making use of stairways was not correct.

Referring to approach signs to stations, Mr. Ackerley said that whilst it might be too complicated to link these approach signs to the signals, would it not be possible to put up a sign, "You are approaching . . ," which would indicate that the station had not actually been reached.

Mr. C. A. MORTON asked whether the anodised aluminium reflectors used for platform fittings were really non-corrodible.

Mr. D. C. Batey inquired as to what height the barrage balloon lighting unit was raised.

Mr. J. G. Holmes, referring to the lighting of shunting yards, said that the use of directional floodlights on high masts, which was general practice in America and on the Continent, was not practicable in this country because atmospheric absorption rendered the beams of light inoperative over long distances for a considerable proportion of the year. It was therefore more appropriate to conditions in this country to employ lighting units which directed the light substantially downwards within an angle of perhaps 60 degrees from the vertical. The best mounting height would probably be about 50 ft., as greater heights would involve difficulties in providing sufficient foundation for the posts, and would give results which would be seriously subject to the effects of atmospheric absorption, whereas lower mounting would give a smaller coverage and longer shadows. A light at 50 ft. should give a useful illumination over an area of about 2,500 square yards.

Referring to escalator lighting, he understood that when long escalators were first installed, some passengers experienced giddiness, and this was overcome by indirect lighting giving a large area of light on the ceiling above the escalator. The authors had described direct lighting fittings as an improvement, and he wondered whether this was applicable only to short escalators.

In the discussion, Mr. Murray had suggested low-level lighting in signal boxes to avoid troublesome reflections from the windows. War-time experience had, however, shown that blue light was not suitable for chart rooms or for rooms in which dark-adapted people were doing detail work, and that yellow or red light gave much better results. Mr. Holmes summarised the relative merits of the two colours, and suggested that any attempt to improve conditions in signal boxes by providing coloured light should be directed towards the use of the longer wave-lengths of the spectrum, rather than the shorter wave-lengths.

Mr. Holmes said he regretted the tendency of authors of papers presented to the Society to employ special supplementary lighting, such as a flash or floodlight, when taking photographs of lighting installations. Such photographs were misleading unless the supplementary lighting were very carefully chosen, and it would be a wise decision of policy if the Society were to ask all authors wishing to illustrate the effect of a lighting installation to use no supplementary lighting and to use the true representation technique which had been developed for street lighting photographs, so far as this could be used for a half-tone block. Such a requirement would add to the difficulties of obtaining photographs, but the added value of the illustrations would surely compensate for the extra labour.

Mr. L. G. Applebee suggested that the judicious use of coloured light in the various rooms on a platform would be a great improvement. It would enable the passenger, for instance, to locate the refreshment room, waiting room, etc. This would also make the station look more cheerful. An example of coloured lighting in connection with railways was to be seen on the western platform of the Piccadilly tube station. The use of coloured lights in the various rooms on terminal stations would also form a pleasing contrast with the main lighting of the station. There was also a lack of really visible signs to the various offices on platforms, and for this purpose he suggested V-shaped signs which could be seen up and down the platform. There was also need for more light at the booking offices. The booking clerk usually had plenty

of light inside, but the passenger was not provided with sufficient light to see what money he was getting out.

Mr. S. ANDERSON asked the authors to explain a little more fully what they had hoped to gain from the barrage balloon experiment, especially as regards the area covered. No information had been given as to the height to which the balloon was sent up. It was obvious that under the vagaries of our weather it could hardly been expected that such a balloon could be maintained in the air all the time it was desired to do shunting. This suggested some form of tower, but he imagined that the economics of the case would determine to what height it was reasonable to erect such a structure. So far as he knew, in this country high power units had already been mounted some 45 ft. or 50 ft. above rail level, and he rather imagined that that was the maximum height reasonably obtainable without going in for expensive structures. That obviously limited the angles at which light could be projected down towards the rails.

Referring to the low mounting of the flush panel units in the sides of the inspection pits shown in one of the illustrations, he would have thought that the illumination on the under-side of the chassis of the locomotive would have been improved if the units had been mounted as near as possible to the top of the sides of the inspection pits instead of low down as had been shown.

As regards the atmosphere in steam locomotive sheds, he suggested that the use of some of the newer plastics materials for the fittings would obviate the corrosion problem.

Mr. C. E. GREENSLADE said that having regard to the usual last-minute rush to catch trains on local services, it would be an advantage to have some system of directional lighting, indicating quite clearly the platform from which a particular train would start. At all events, such a system should be provided on the larger stations where there were a number of platforms. In this and certain other respects he felt the passenger was often forgotten. He emphasised what had already been said as to the need for some lighting on the edge of the platform to indicate to the passenger whether the train had really stopped or not, and, he added, there were many accidents on buses during the blackout because the steps leading out of the bus were not adequately lighted. This was avoided later by a spot-light showing both the step and the ground immediately beneath.

THE PRESIDENT remarked that the present form of terminal station was invariably constructed on the Crystal Palace plan, with a huge glass roof. That design was settled at a time when artificial lighting was very different from what it was to-day, and it resulted in a sort of tunnel effect and, of course, it was extremely difficult to keep clean. If new terminal stations were being built to-day, would that same scheme be adopted or would there be something more resembling the conditions in the Lighting Service Bureau lecture hall, which gave a lighted background?

Dr. J. W. T. WALSH (*Communicated*).—I should like to ask the authors whether they had any experience of the use of red light in signal boxes to avoid loss of dark adaptation by signalmen. This had been found very valuable for aerial and sea navigation, provided the light used was really red, with no admixture of orange.

In connection with their remarks on stair lighting, I should like to say that

I find the steps connecting Waterloo Bridge with the Embankment most disconcerting owing to the use of a *dark* nosing on the treads. The contrast is there, but I feel that it is reversed and that the nose should be light against a dark background, not vice-versa, as one is naturally inclined to the impression that a lighter object is nearer than a darker one.

THE AUTHORS, replying to the discussion, said: We would like in the first place to express appreciation of the many valuable comments and criticisms of points in the paper which were brought out in the discussion. It will be more convenient to reply to the points raised by dealing with them under separate headings, rather than covering the remarks of each individual separately.

Engine Shed Lighting.

One or two speakers referred to the possibility of awkward glare when bare lamps are used. No doubt the smooth outer casing suggested by Dr. Aldington would be an improvement, but that and the fitting suggested by Mr. McGibbon would involve extra cleaning and that, we feel, is the crux of the matter until, as Mr. Bennett suggested, the ventilation of the engine sheds has been so much improved that the atmosphere is rendered less troublesome.

Mr. Anderson commented on the height of the flush panels for pit lighting by fluorescent tubes. These were no doubt placed fairly low down in the concrete structure so as to permit of the requisite strength near the top edge of the pit where the rails are supported, but this was not found to be any drawback as the cross reflection from the panels on each side of the pit was found to give a very good upward illumination.

Yard Lighting.

We were glad to hear emphasis placed both by Mr. Bennett and Mr. McGibbon on the fact that this i sa very special lighting problem and certainly must not be treated as equivalent to street lighting. Whilst we agree with Mr. Bennett's comment that silhouette lighting is still the main concern in marshalling yards, we feel that more should be done to provide good background lighting, and we hope that this will be secured by the system of high elevation lighting which we have advocated.

High Elevation Lighting.

Our experiments in this direction evidently caused a good deal of interest, and it is perhaps to be regretted that a little more detail was not given in the body of the paper. The height at which the experiment was carried out was 150 ft. above ground. The balloon was temporarily raised to 200 ft., but it was generally agreed that the 150 ft. height appeared on the whole to give the best effect.

Several speakers referred to American flood-lighting, but this, of course, is an entirely different matter, as the essence of the experiment described was that the light was thrown down in as near a vertical direction as possible. Mr. Holmes suggested a height of 50 ft. as probably representing the practical limit for the construction of a tower, and pointed out that at an angle of about 60 deg. from the vertical a good result should be obtained. We feel, however, that a much greater height is desirable, for the very practical reason that it reduces the number of points of illumination, and it is the finding of sites for lighting poles that is usually the difficulty in all but very modern marshalling yards which have been specially designed to allow for lighting.

Moreover, enquiries indicate that the expense of a mast of about 150 ft.

should not be prohibitive, and we hope that further experiments now being carried out will confirm the earlier experiment with the barrage balloon. The whole point of the proposal is to supplement the special lighting at certain key points with a good background lighting of, say, three or four times moonlight, and it is thought that this will greatly aid the safety and speed of shunting work.

We are grateful to Dr. Aldington for suggesting that some of the modern high brightness sources could be used for this purpose in order to increase the efficiency of the scheme.

With regard to the question of fog, enquiries indicate that the ordinary overhead fog rarely becomes intense below 150 ft., and when it does, it is so dense that to a large extent work in marshalling yards ceases. It may be mentioned that we have in mind the possibility of being able to adjust the level of the light source on the high mast so that it can be lowered if fog conditions make this desirable.

Reference was made in the paper to an illumination level of 0.075 foot-candles being aimed at, but it is quite possible that something better than this will ultimately be obtained. The range of illumination in the trial may be estimated from the fact that it was about 1.0 foot-candle immediately under the light source and 0.025 foot-candle at a distance of 400 ft. from the axis.

Signal Cabins.

Mr. Murray, Mr. Holmes, and Dr. Walsh referred to the possibility of using special coloured light in order to help signalmen to maintain "dark adaptation." We are not aware of any trials in this direction, and we think it would be found impracticable for the reason that there are in the signal frame many important indications dependent on colour discrimination, and unless the illumination has a reasonable approximation to white light it is probable that confusion would arise. Incidentally, it may be remarked that the makers of signal frames do not assist illuminating engineers when they bring out designs with very highly polished metal handles and other features giving a maximum of reflection, as though they were determined to secure some images in the windows of the signal cabin.

Mr. Lowson suggested a non-reflective window might be obtained by sloping the window outwards, and we think this is a device which might well be tried. It was actually suggested some time ago on the Southern Railway, but was turned down on account of alleged structural difficulties. However, now that more stress is being laid on the importance of dark adaptation sight in the signal cabin, it might be that this proposal will be reconsidered. It is, of course, important to remember that the windows must be readily opened for the signalmen to communicate with staff outside, and this would militate against any curved glass scheme, such as has been adopted for shop windows.

Mr. Murray's suggestion for a canopy type of indirect lighting fitting is well worthy of consideration. It would certainly appear less austere than the very plain industrial reflectors that have been used in one of the examples shown, but we doubt whether the ultimate effect would be much better from the point of view of dark adaptation. The real difficulty is that we must light certain features of the frame fairly brightly, and as these features are bound to reflect light there are bound to be certain images in the glass. Therefore, all

that one can do, short of some special windows, is to keep the general brightness to a comparatively low order.

Lighting of Stairs.

Mr. Murray made some very valuable comments on this subject and quite rightly stressed the importance of such features as hand rails and regularity in steps as affecting the safety of users even more than good illumination. Hand rails too closely spaced would, however, cause congestion.

We still feel that the contrast between the nosing of the tread and the remainder is by far the most important feature and we are surprised at Dr. Walsh finding the staircase at Waterloo Bridge unsatisfactory. It seems to us to matter little whether the nosing is dark against a light background or light against a dark background, but the former is naturally the more practical scheme, since the edges of the treads always become dirty with use and the inner portion of the tread is more likely to retain its light colour.

Mr. Holmes referred to the possibility of long escalators causing giddiness, but we do not think that this can be taken care of to any extent by a particular system of lighting. It is quite wrong to suppose that direct lighting is necessarily glaring. If properly designed, as in the example shown by the authors, it is much simpler and can be more efficient than an indirect or semi-indirect installation. Too much stress has been placed in the past on methods of indirect lighting, which we regard rather as an expensive luxury. Observation on the Tube lines shows how difficult it is to maintain indirect lighting to a good standard and the fact that the Transport Board have recently used very effective direct lighting by fluorescent tubes on the long escalator at Bethnal Green rather confirms our view.

Name Signs.

We agree with Messrs. Barton and Applebee that there is room for great improvement in station signs generally, but the greater use of well-illuminated enamel plates is already making the position much better so far as station names are concerned.

Mr. Ackerley's suggestion for an approach sign with the words "You are now approaching, etc., etc.," is a device which has already been adopted in principle, if not in detail, by the provision of a sign a little way outside Victoria Station, which gives the name of the station and an arrow with the words "quarter mile" underneath. Mr. Ackerley's proposal would be another way of dealing with the matter, but we think that the operating department would feel that there was still a risk of passengers alighting if a train pulled up at the home signal and they saw an illuminated name sign immediately outside the carriage window. It is surprising how readily people can be confused if a train pulls up just short of a station platform. We rather think, as stated in the paper, that the greater development of loud speaker announcements on station premises will tend to minimise the importance of the name signs, but it will be a long time before the latter will cease to be an important feature at the smaller stations.

Miscellaneous Comments.

In reply to Mr. Morton's query, it must be admitted that anodised aluminium reflectors have not proved in service to give all the results that were expected of them, although they do not fail as rapidly as some other reflecting surfaces.

One or two members commented on destination indicators and urged among other things that these should have larger lettering and should be of a character

which gives the most complete possible information. Whilst we agree that this is the ideal, we must emphasise that to give all the necessary information in large-scale letters would involve a destination indicator of mammoth size.

We quite agree with Mr. Holmes' remarks regarding the desirability of a proper technique for photographs of lighting installations, but unfortunately we had to rely on the services of photographers unused to the true representation technique and also, owing to circumstances, had to make use of photographs taken for other purposes.

With regard to the use of skylights in box wagons, we do not understand why Mr. Bennett thinks that it would take a long time to effect the alterations suggested. It has been noticed recently that the method advocated has already been adopted in Switzerland for mail van traffic, and it would seem that it might well be carried out in all new construction in this country straight away, leaving older wagons to be converted gradually.

Several speakers remarked on the desirability for improved conditions in waiting rooms. In fact, the station waiting room is as much a by-word as the refreshment room sandwich. It may be interesting to point out that the Southern Railway some years ago had quite a campaign in favour of modernising waiting rooms in all respects, including lighting and heating, but this only proved how necessary it is to educate the public to care for the amenities provided for them. It was lamentable to see how very rapidly all the improved features deteriorated through careless or even malicious damage.

We have noted with interest Mr. Ackerley's reference to the possible illumination of high roofs in order to avoid the appearance of gloom so often resulting from lack of this light. We entirely agree and would point out that the idea has already been put into operation at Waterloo Station and elsewhere.

The President asked if there was likely to be any modification in the design of roofs for terminal stations. We think it very unlikely that there will be a perpetuation of the large domed roof. All the indications are that separate umbrella roofing to each platform is likely to be adopted and the lighting technique will no doubt follow this type of construction. How soon we shall advance to conditions resembling those in the Lighting Service Bureau lecture hall is a matter for conjecture.

Whilst always ready to welcome any new device, we do feel that the first and foremost lesson from experience is that simplicity always pays in the long run.

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

With a view to avoiding possible confusion with other publications, reference to these Transactions should be in the form :—"Trans. Illum. Eng. Soc. (London)."

Additions to List of Members

The following applicants have been duly elected by the Council to membership in the Society, and their names have been added to the list of members:—

SUSTAINING MEMBERS:—

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47/53, Chapel Street, SALFORD, 3. *Representative*: Mr. W. H. Swain.

W. H. Smith and Co., Electrical Engineers, Ltd.,
12, York Street, MANCHESTER, 2. *Representative*: Mr. W. H. Smith.

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Heald, I. M. .....89, Feltham Road, Ashford, MIDDX.
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Langsdon, E. A. .....35, Camborne Road, Morden, SURREY.
Lay, J. E. ....."Edgecombe," Woodlands Avenue, Farnham, SURREY.
Legg, W. S. ....."Iona," 102, Chestnut Avenue, FOREST GATE, E.7.
Letts, N. E. .....59, Tanworth Lane, Shirley, BIRMINGHAM.
McQueen, D. B. .....26, Tilstock Crescent, Prenton, BIRKENHEAD.
Mercer, R. C. .....12, Elgar Avenue, Tolworth, Surbiton, SURREY
Monteith, J. .....Kirkland House, 39, Blairhill Street, COATBRIDGE.
Morgan, E. C. B. .....24, Inglewood Road, WEST HAMPSTEAD, N.W.6.
Morrish, S. J. .....151, Broadfield Road, HITHER GREEN, S.E.6.
Mounsdon, M. H. .....Mellow Lodge, Mellow Lane, Hayes End, MIDDX.
Nicholls, J. D. .....64, Bills Lane, Shirley, BIRMINGHAM.
Parr, Miss B. M. .....Carrick House, Stafford Road, Eccles, LANCS.
Paskin, S. H. ....."Mahzel," 523, Wolverhampton Rd., Langley, BIRMINGHAM.
Price, C. E. .....28, Market Street, Hoylake, CHESHIRE.
Rawson-Bottom, W. E. 17, Irwin Road, Guildford, SURREY.
Richardson, C. H. G. 15, Beedell Avenue, Westcliff-on-Sea, ESSEX.
Sewell, J. .....4/6, New York Road, LEEDS.
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Stevens, R. W. .....8, Chalkpit Terrace, Dorking, SURREY.
Turner, R. .....13, Granville Gardens, Jesmond, NEWCASTLE-ON-TYNE.
Unter, N. E. .....30, Sh. Cherif Pacha, Cairo, EGYPT.
Webb, T. G. E. .....85, Sylvan Way, Sea Mills, BRISTOL, 9.
West, W. J. .....Fingle Bridge, Woodfield Avenue, Hildenborough, Tonbridge, KENT.
Willis, H. .....34, Lincoln Road, PETERBOROUGH.
Wilson, D. S. ....."Thornhill," 24, Greenway, Greasby, Wirral, CHESHIRE.

TRANSFER FROM CORPORATE MEMBER TO ASSOCIATE:—

Wilkinson, C. G. E....The Rigs, 207, Coventry Road, NUNEATON.

SESSIONAL MEETING IN LONDON

A Sessional Meeting was held at the E.L.M.A. Lighting Service Bureau, Savoy Hill, London, W.C.2, at 6 p.m., on Tuesday, December 10, 1946.

Mr. J. S. Dow (President) was in the chair.

The minutes of the last meeting having been taken as read and confirmed, the hon. secretary announced that following the decision of the Council a suitable badge of office to be worn by the President had now been prepared and he called upon the senior Past-President present (Mr. A. Cunnington) to invest the President with the badge of office. Mr. Cunnington, investing Mr. Dow with the insignia, expressed his great pleasure at having the opportunity to do so. Mr. Dow in reply paid tribute to Mr. P. V. Burnett who had been responsible for designing and procuring this pleasing emblem.

The President then called upon Mr. A. Cunnington and Mr. G. W. Golds to deliver their paper entitled "Railway Lighting. Some Lessons from Experience and Views on the Future." The authors discussed the general requirements of railway lighting installations and referred in some detail to the special problems which arise in the lighting of good sheds, shunting yards and other places. In the latter part of the paper the authors made reference to possible future developments and mentioned experiments that had been made.

After a vote of thanks, proposed by the President, had been carried a discussion was opened by Mr. A. R. McGibbon who was followed by Mr. M. G. Bennett, Mr. P. S. Barton, Mr. E. W. Murray, Mr. J. C. Lowson, Dr. J. N. Aldington, Mr. R. O. Ackerley, Mr. C. A. Morton, Mr. D. C. Battie, Mr. J. G. Holmes, Mr. L. G. Applebee, Mr. S. Anderson and Mr. C. E. Greenslade. The authors replied to the discussion and the meeting terminated.

ANNUAL DINNER

The attention of members is invited to the annual dinner, to be followed by dancing, which has been arranged to take place on Wednesday, May 14 next, at the Grosvenor House, Park-lane, London. The price of tickets is 32s. 6d. each. Evening dress will be optional.

As this will be the first occasion on which the annual dinner has been held since the outbreak of war in 1939 it is hoped that members will make a special effort to be present. Members may bring guests though initially it is necessary to limit members to one guest only. If conditions permit, however, opportunity will be afforded to members to obtain additional tickets after April 19. Attendance must unavoidably be restricted to a maximum of 400 persons and early application for tickets is recommended.

I.E.S. Fellowship.

The following applications for Fellowship have been accepted:—

L. R. Brown, J. G. Christopher, B. B. Hayter, L. C. Rettig.